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# The state of environmental sustainability considerations in mining

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ABSTRACT

In the Global Mining Initiative, the mining industry came together to understand the industry's role in the transition to sustainable development and to ensure its long-term contribution. The industry has since then come a long way and improved its sustainable development performance in many areas. But how far has the industry been considering environmental ("strong") sustainability in its approach? And how does this compare to companies in other sectors and leading organizations such as the United Nations, World Business Council for Sustainable Development and the Global Reporting Initiative?

This paper presents results from a literature review, looking at how far the mining industry has considered environmental sustainability in its approach. It explores, if the current efforts of the largest mining companies are aligned with the efforts of companies from other industry sectors, as well as the position of leading organizations.

We conclude that the mining industry is not setting on the wrong sustainability paradigm at this stage, but is at risk of falling behind societal expectations on climate change and the leaders from other industries on natural capital considerations. The industry can improve by considering the Paris Agreement in its approach to climate change, considering natural capital as an industry, e.g. through working with the Natural Capital Coalition and more broadly by pro-actively thinking about what the consequences of "strong sustainability" would mean for their business models.

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## 1. Introduction

Mining has for centuries, even millennia, been a source of great economic wealth but also social and environmental concern (e.g. Agricola, 1556). The "great acceleration" of economic growth after World War II (Steffen et al., 2015a) meant that demand for mineral resources was growing exponentially (e.g. Moser, 2016). This increase in production meant that mines became more in numbers and larger and so did the social and environmental consequences – leading to ever more conflicts- e.g. to name just two related to the largest mining companies in the world, BHP and Rio Tinto, Ok Tedi in 1984 and Bougainville Copper in 1989 - and putting ever more pressure on the industry to improve its social and environmental performance.

Based on these concerns, the CEOs of the largest mining companies came together in 1998 at the World Economic Forum in Davos and decided that a new approach to tackle these problems was needed. The Global Mining Initiative (GMI) was launched to define what sustainable development (SD) should mean to the industry and how it would contribute:

> *One of the greatest challenges facing the world today is integrating economic activity with environmental integrity, social concerns, and effective governance systems. The goal of that integration can be seen as 'sustainable development'. In the context of the minerals sector, the goal should be to maximize the contribution to the well-being of the current generation in a way that ensures an equitable distribution of its costs and benefits, without reducing the potential for future generations to meet their own needs. The approach taken to achieve this has to be both comprehensive – including the whole minerals chain – and forward-looking, setting out long-term as well as short-term objectives.* (IIED 2002)

Since then, mining has progressed in many ways including its understanding of sustainable development, its approach towards health and safety and towards community relations (see e.g. Buxton, 2012; Franks, 2015). But how far has the industry been considering environmental sustainability in its approach?

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### 1.1. Environmental sustainability and sustainable development

It was environmental problems, as a result of the "great acceleration" that brought the issue of environmental sustainability to the attention of the public. The Club of Rome published "The Limits to Growth", which states that

> "*the earth's interlocking resources – the global system of nature in which we all live – probably cannot support present rates of economic and population growth much beyond the year 2100, if that long, even with advanced technology*" (Donella et al., 1972)

The United Nations (UN) played a key role in developing the agenda. In 1987, the UN's World Commission on Environment and Development came up with a definition of sustainable development that today is still the one most often referred to:

> "*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*" (WCED, 1987, paragraph 1)

What is interesting though is that the next sentences, which link sustainable development to sustainability, are hardly ever considered in these references:

> "*It contains within it two key concepts*:
>
> - *the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and*
> - *the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.*
>
> *Thus, the goals of economic and social development must be defined in terms of sustainability in all countries - developed or developing, market-oriented or centrally planned. Interpretations will vary, but must share certain general features and must flow from a consensus on the basic concept of sustainable development and on a broad strategic framework for achieving it.*" (WCED, 1987 paragraphs 1, 2).

Although it does not give a clear definition of sustainability ("interpretations will vary") there is a link between development and ecological limits.

Five years later, one of the outputs of the UN's Conference on Environment and Development in Rio de Janeiro, the so-called Rio declaration (United Nations Conference on Environment and Development, 1992) put a stronger emphasis on human development relative to environmental protection.

The Rio declaration was key for SD to be modelled using three pillars or spheres on equal footing as shown in Fig. 1.

Further UN conferences with relevance were the Millennium Summit in New York in 2000 and the Conference on SD, or Rio +20, in 2012. At the former, the Millennium Development Goals (MDGs), a set of eight goals were agreed upon. At the later, the key result was the non-binding document "The future we want" in which it was agreed to develop the Sustainable Development Goals (SDGs, see below) to succeed the MDGs.

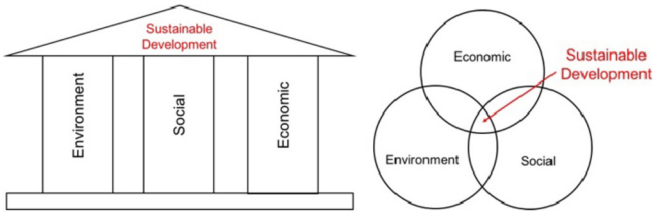


**Fig. 1.** Three pillars or spheres of sustainable development.

### 1.2. Strong vs. weak sustainability

The above described UN processes highlight a key aspect relevant to the sustainability debate: The differentiation of strong vs. weak sustainability.

"Weak sustainability" can be seen as an extension of neoclassical welfare economics and is based on work by Robert Solow (e.g. Solow, 1986) and John Hartwick (e.g. Hartwick, 1977), were in principle human capital (infrastructure, education, living standards, culture, etc.) can substitute natural capital (water, air, mineral resources, but also ecosystem services such as pollination by bees or photosynthesis by plants, etc) ("substitutability paradigm") and sustainability is achieved when the total stock of capital is grown or at least sustained for future generations.

In opposition to this view is "strong sustainability", which in essence says that the buildup of human capital is not completely interchangeable with, but limited by natural capital. This means there are environmental limits that have to be considered in order to ensure environmental sustainability ("non-substitutability paradigm") (e.g. Ayres et al., 1998; Neumayer, 2003). Neumayer (2003) states that science can't provide an answer to which sustainability paradigm is "correct", but argues that "a combination of distinctive features of natural capital with the prevalence of risk, uncertainty and ignorance make a *persuasive* case for the preservation of certain forms of natural capital that provide basic life-support functions" (p. 4).

An example to illustrate the difference between both views is the use of coal in energy production, which would be limited under "strong sustainability" by climate change, air pollution, etc. but unlimited under "weak sustainability" if the benefits of cheap energy and jobs outweigh the environmental concerns. Whilst this is only one example it shows the importance of the paradigm differentiation to the mining industry, as it can have a significant impact – from operational water use restrictions (e.g. South African platinum mines in 2013), shareholder resolutions on climate change (as faced e.g. by Glencore in 2016) all the way to threats to the business model faced by coal mining companies.

We argue that, with the Rio declaration and the emergence of the three pillar model ("weak sustainability"), the sustainability aspect, expressed through environmental limits ("strong sustainability") got sidelined. In recent years, this "strong sustainability" position or at least the parts of it related to natural capital as stated by Neumayer (2003) above is becoming increasingly important on the societal agenda, given pressures such as climate change and biodiversity loss.

Could the mining industry again be falling behind societal expectations (Tost et al., 2017) by setting on the wrong paradigm? To test this argument, we conduct a literature review into the current state of the global environment (Section 2), how this relates to sustainability considerations in academia and leading institutions (Section 3) and how it relates to the status in the mining industry (Section 4) and compares to other industries (Section 5) before presenting our conclusions in Section 6. With regards to environment, we select and focus on three issues considered highly material to mining including by the industry itself: climate change, water and biodiversity.

## 2. Climate change, water and biodiversity

The "great acceleration" has led to tremendous growth in the demand for mineral resources. More generally, it has let to

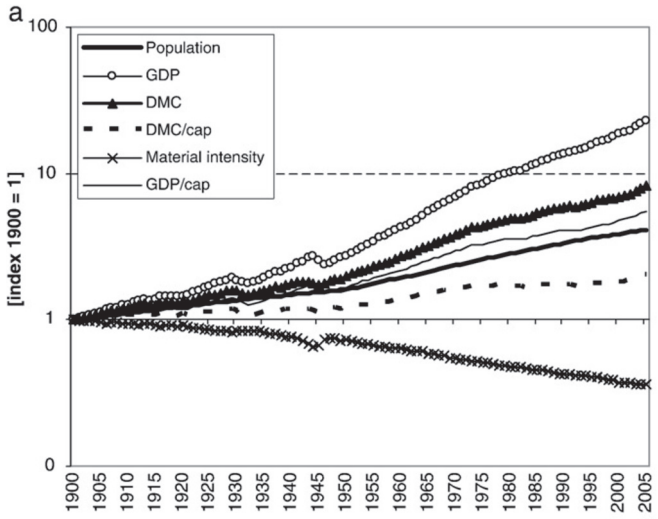


**Fig. 2.** Development of materials use (DMC), population and GDP; Sources: Krausmann et al. 2009, Maddison 2008.

tremendous global growth in GDP and population. Global population grew 5-fold to currently 7.5 billion and global economic output as measured by GDP grew more than 20-fold, as shown in Fig. 2 (from Krausmann et al., 2009).

On the upside, this meant big improvements to the living standards of a large proportion of humanity. On the downside, it meant a massive transformation of the environment, with such an impact that we are seeing the beginning of a new geological age, the Anthropocene (Steffen et al., 2007).

The UN Environmental Programme (UNEP), with its mandate of "keeping the global environment under review" states the situation in its latest Global Environmental Outlook (GEO 5) as follows:

> "*The currently observed changes to the Earth System are unprecedented in human history. Efforts to slow the rate or extent of change – including enhanced resource efficiency and mitigation measures – have resulted in moderate successes but have not succeeded in reversing adverse environmental changes. Neither the scope of these nor their speed has abated in the past five years. As human pressures on the Earth System accelerate, several critical global, regional and local thresholds are close or have been exceeded. Once these have been passed, abrupt and possibly irreversible changes to the life-support functions of the planet are likely to occur, with significant adverse implications for human well-being.*" (UNEP, 2012, p. 6, p. 6)

### 2.1. Climate change

UNEP sees climate change as "one of the most serious challenges" to the global community. CO2 emissions and global temperatures are still rising, with CO2 now "*at levels not seen for at least the last 800000 years*" (IPCC, 2013).

In December 2016 the "Paris agreement" within the United Nations Framework Convention on Climate Change (UNFCCC) process came into force, with a goal of "*holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change*" (UN FCCC, 2015, p.3), thus providing an absolute goal, based on an environmental limit.

### 2.2. Water

Regarding water, UNEP's GEO5 report states

> "*(…) there are concerns that the limit of sustainability of water resources, both surface- and ground-water, has already been reached or surpassed in many regions, that demand of water continues to increase and that water-related stress on both people and biodiversity is escalating rapidly. Global water withdrawals have tripled over the last 50 years; aquifers, watersheds and wetlands are increasingly at risk yet are often poorly monitored and managed. The rate at which global groundwater stocks are decreasing more than doubled between 1960 and 2000. Today, 80 per cent of the world's population lives in areas with high levels of threat to water security, with the most severe threat category a effecting 3.4 billion people, almost all in developing countries.* (UNEP, 2012, p. 10, p. 10)

Other than for climate change or biodiversity there are no global processes or treaties in place on how to manage water sustainably (except for it being considered as a goal in the SDGs, see below), but there are some regional or local ones, e.g. in Australia.

### 2.3. Biodiversity

As for biodiversity, there has been a global process in place since the Rio Earth Summit in 1992, the Convention on Biological Diversity (CBD), based on a recognition that on the one hand the Earth's biological resources are vital to humanity's economic and social development, whilst at the same time, the threat to species and ecosystems caused by human activities has never been so great as it is today. In October 2010, the CBD adopted a revised Strategic Plan for Biodiversity, including the Aichi Biodiversity Targets, for the period 2011–2020. They include five goals and 20 targets, some of which set absolute limits (CBD, 2017).

In its Global Biodiversity Outlook 4 the CBD, measuring progress against the Aichi Biodiversity Targets notes that there is progress on some of the targets, but that overall progress is not sufficient to achieve the targets and that *"pressures on biodiversity will continue to increase at least until 2020, and that the status of biodiversity will continue to decline*". (Secretariat CBD, 2014, p. 3, p. 3).

## 3. Academia and leading institutions

Ecological Economics is an area of academic research most relevant in the context of "strong sustainability". Influenced by the "The Limits to Growth" (Donella et al., 1972) and contrary to neoclassical economics, ecological economics sees the economy as a subsystem of the environment, the "Earth system", which is materially a (more or less) closed system, only open to solar energy. In this view, economic growth *"encroaches on other parts of the finite and non-growing whole, exacting a sacrifice of something – an opportunity cost"* (Dali and Farley, 2011), which makes it possible that at one stage economic growth becomes uneconomic, as the opportunity cost outweighs the growth. The argument now is that we have already reached this state (i.e. "a full world economy") and that *"the welfare from economic services increases while the welfare from ecological services diminishes"* (Dali and Farley, 2011). To consider this in economics, ecological economists suggest, in addition to the traditional human capitals, to also include natural capital.

In recent years, the consideration of natural capital has made progress, with the organizations mentioned below playing a role but also through the Natural Capital Coalition, a global collaboration to harmonize approaches.

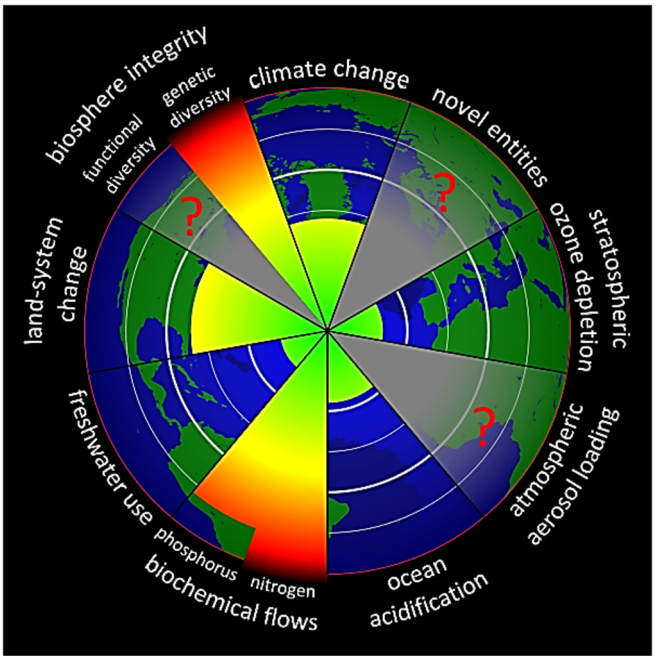


**Fig. 3.** The Planetary Boundaries, acc. to Steffen et al., 2015a,b.

In 2009, a group of Earth system scientists, led by Will Steffen and Johan Rockström, published a concept called the Planetary Boundaries (Rockström et al., 2009; Steffen et al., 2015b). Fig. 3 illustrates the framework.

The framework "*defines a safe operating space for humanity based on the intrinsic biophysical processes that regulate the stability of the Earth System*" as a precondition for sustainable development. Crossing these boundaries brings the risk of "*irreversible and abrupt environmental change*", making our planet less habitable for humans (Steffen et al., 2015a,b). Of the three environmental areas looked at in this paper, the ones for biodiversity (genetic diversity) and climate change are considered core and they have already crossed the suggested boundaries whilst freshwater use is still within its boundary.

Other examples of science based frameworks for sustainability are The Natural Step, based on four principles of how society should relate to nature and within itself as shown in Fig. 4 (The Natural Step, 2017) and the Ecological Footprint, accounting for the demand (ecological footprint) on and supply (biocapacity) of nature for humans tracking the use of six categories of productive surface areas: cropland, grazing land, fishing grounds, built-up land, forest area, and carbon demand on land. *"Today humanity uses the equivalent of 1.6 Earths to provide the resources we use and absorb our waste"* (Global Footprint Network, 2017). An extension of the Ecological Footprint is the Living Planet Index documenting the extent of human pressure on the planet and how it is impacting the natural world (WWF, 2016).

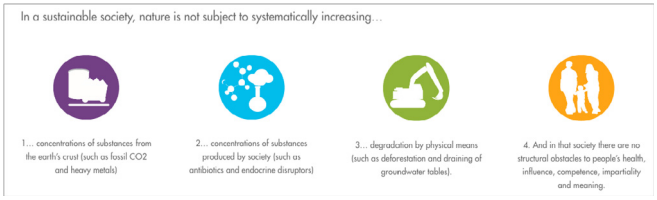
In a sustainable society, nature is not subject to systematically increasing...
1... concentrations of substances from the earth's crust (such as fossil CO2 and heavy metals)
2... concentrations of substances produced by society (such as antibiotics and endocrine disruptors)
3... degradation by physical means (such as deforestation and draining of ground-water tables).
4. And in that society there are no structural obstacles to people's health, influence, competence, impartiality and meaning.

**Fig. 4.** The Natural Step principles, Source: The Natural Step 2017.

To mobilize the global scientific knowledge on the challenges of sustainable development, UN Secretary-General Ban Ki Moon in 2012 launched the Sustainable Development Solutions Network (SDSN). The SDSN supports Rio+20, but with one major difference: It talks of environmental sustainability:

> "*The SDSN fully supports the Rio + 20 vision of sustainable development as a holistic concept addressing four dimensions of society: economic development (including the end of extreme poverty), social inclusion, environmental sustainability, and good governance including peace and security. Societies aim to achieve all four dimensions. Failures in one area, such as environmental sustainability or gender equality, can undermine progress in others, such as the eradication of poverty.*" (SDSN, 2014, p.ix)

In its "priority challenges of sustainable development" it also makes reference to the planetary boundaries. (SDSN, 2014)

The examples above change the description of sustainable development to a model as shown in Fig. 5 and support a "strong sustainability" position.

How far have the above examples been taken on? We look at the UN once again and two of the most advanced organizations in this space, the World Business Council for Sustainable Development (WBCSD) and the Global Reporting Initiative (GRI).

The UN's webpage (UN, 2017) defines sustainable development as "*development that promotes prosperity and economic opportunity, greater social well-being, and protection of the environment*". It states "*the need to complete the job of eradicating poverty*", as the key driver for the 2030 Agenda for Sustainable Development or SDGs, as they are known. The SDGs, adopted in 2015, are a set of 17 goals and 169 targets and are to "*transform our world*" and set "*the 2030* agenda *for sustainable development*". Other than the MDGs, the SDGs are global goals for all countries and are broader, containing social (e.g. "no poverty" or "zero hunger"), economic (e.g. "decent work and economic growth") and environmental goals (e.g. "climate action or "life below water") and a governance related goal "partnerships for the goals". Whilst the SDGs align with the UN processes on climate

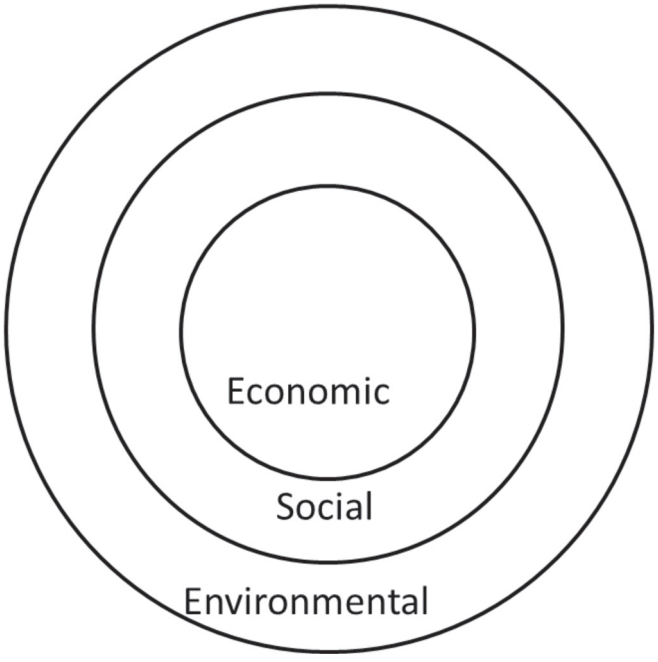


**Fig. 5.** Nested circles model of sustainable development, based on environmental (and social) sustainability.

change and biodiversity (which include absolute environmental targets), we argue that they are based on the three pillar model and support mainly a "weak sustainability" position.

The WBCSD is a "global organization of over 200 leading businesses working together to accelerate the transition to a sustainable world". In 2010, it published its "Vision 2050" (WBCSD, 2010), which sets out a vision for the pathway to a sustainable world, with *"a global population of some 9 billion people living well, within the resource limits of the planet by 2050."* It has since published its "Action 2020" (WBCSD, 2014), which is a first action plan on route to achieving the "Vision 2050". Current work includes "Redefining value" - frameworks for natural (via the Natural Capital Coalition) and social capital accounting. The WBCSD's position is one of "strong sustainability".

The GRI is an independent international organization dedicated to the development of standards for sustainability reporting, currently used by many thousands, mainly large organizations, including the mining companies considered in the analysis below. In October 2016 it published its latest set of 36 standards, consisting of universal standards GRI 101–103 and specific standards to report on material economic (GRI 200), environmental (GRI 300, including standards for GHG emissions, water and biodiversity, the three issues considered in this paper) and social (GRI 400) topics. A requirement of the updated standard is for reporting organizations to put their performance in the wider context of sustainability. It leaves it up to the organization to decide if this context is one of weak or strong sustainability; with GRI in the guidance (background information, explanation or examples) to this requirement making reference to "limits and demands" - signs of "strong sustainability":

> *Therefore, the aim is to present the organization's performance in relation to broader concepts of sustainability. This involves examining its performance in the context of the limits and demands placed on economic, environmental or social resources, at the sectoral, local, regional, or global level.* (GRI, 2016, p.12, p.12)

In conclusion, whilst we find examples supporting "strong sustainability" in academia and the organizations we looked at, they have not, except for climate change and biodiversity, translated into the societal mainstream, which we consider to be expressed through the SDGs.

## 4. Mining – weak or strong?

In December 2014 this journal published a special volume on the "sustainability agenda of the minerals and energy supply and demand network" (Moran and Kunz, 2014a,b). Considering all papers submitted, Moran and Kunz (2014a,b) propose a definition for "Operating Sustainably" at a single operational level and at regional scale. At the global scale they argue for "weak sustainability":

> "*The tension between the extents to which capitals can be exchanged has been debated particularly in terms of the capability of the natural resource base to cope with the economic approach that equates social development with economic growth. Irrespective of these debates, the concept of weak sustainability provides a rationale for mineral extraction in terms of providing necessary materials and as a primary industry generating wealth for redistribution ultimately being the means of improved quality of life and environment.*" (Moran and Kunz (2014a,b), p.24)

In his book "Mountain Movers" (Franks, 2015), Daniel Franks provides a detailed overview of the current status of sustainability in the mining industry, based on the GMI and including a chapter on environment. It provides a good overview of current initiatives (e.g, related to environment, the Cyanide Code) and numbers/trends, i.e. stating that making progress on CO2 and water reductions will be a challenge with declining ore grades and that the industry, through ICMM and a partnership with the International Union for Conservation of Nature (IUCN) has made good progress on biodiversity with potential to lead to positive impacts. The book does not go into a discussion about weak vs. strong sustainability, coming to the conclusion that whilst progress has been made, it is slow, has not been reaching throughout the whole mining industry and needs a renewed effort, maybe linked to the SDGs.

The ICMM (International Council on Mining and Metals) was created in 2001 as a result of the GMI. Today it represents over 20 mining and metals companies and over 30 regional and commodities organizations. It developed 10 principles and eight position statements for its members and the mining industry to follow. Two of the principles relate directly to climate change, water and biodiversity:

*Principle 6*: *Pursue continual improvement in environmental performance issues, such as water stewardship, energy use and climate change*.

*Principle 7: Contribute to the conservation of biodiversity and integrated approaches to land-use planning* (ICMM, 2003).

Also, two of the position statements relate to climate change and water. Whilst the one on climate change is from 2011 and seems outdated (Buxton (2012) speaks of a "wait and see" approach the industry has broadly taken on climate change), the one on water was published in January 2017 requiring ICMM members, amongst other things, to collaborate to use water environmentally sustainable, ideally at a local/catchment level (ICMM, 2017).

Except for this new position on water, the ICMM supports a "weak sustainability" position.

Other prominent sustainability frameworks developed within the mining industry are "Towards Sustainable Mining" (TSM) from the Mining Association of Canada (MAC), "Enduring Value" from the Minerals Council of Australia (MCA) and the Initiative for Responsible Mining Assurance (IRMA). Established by MAC in 2004 TSM has since been adopted in other countries like Argentina, Botswana and Finland. Its guiding principles make reference to sustainable development, based on the first sentence of the Brundtland definition. Similar to the ICMM's position papers TSM has developed protocols and frameworks for key sustainability issues, including climate change, biodiversity and water (MAC, 2017). MCA's "Enduring Value" framework is directly based on ICMM's 10 principles to which, through its "Enduring Value Principles", more detailed elements (actions) and verifiable outcomes (indicators) are added. It requires "*an environmental management system focused on continual improvement*" and "*exploration, operations and closure are planned to avoid and/or minimise impacts on ecological and cultural values of legally protected areas*" (MCA, 2015). IRMA was founded in 2006 by a broad multi-stakeholder coalition. IRMA is currently developing a second version of standards for environmental and social issues related to mining, including for climate change, water quality and quantity and biodiversity. It is developing a system of independent, third-party certification which it is planning to beta test in late 2017. IRMA's water and biodiversity draft V2.0 standards can be seen as supporting "strong sustainability" whereas its draft V2.0 standard on climate change does not (it includes a note stating that *"in the future, the IRMA Steering Committee may consider the development of numeric criteria to further guide mining GHG emissions as appropriate"*) (IRMA, 2017).

Overall, these three frameworks can be considered to support "weak sustainability", with IRMA being the most advanced towards "strong sustainability" given its standards for water and biodiversity.

**Table 1**
Mining & metals companies selected.

| Name | Reason for selection (commodity, memberships, Geography) |
|---|---|
| Rio Tinto | Diversified, ICMM, DJSI, UK/Australia |
| BHP Billiton | Diversified, ICMM, Australia/UK |
| Anglo American | Diversified, ICMM, DJSI, UK/South Africa |
| Glencore | Diversified, ICMM, Switzerland |
| Areva | Uranium, ICMM, France |
| ArcelorMittal | Iron and steel, WBCSD, Luxembourg |
| Vale | Diversified, WBCSD, Brazil |
| Newmont | Gold, ICMM, DJSI (mining leader), USA |
| Barrick Gold | Gold, ICMM, DJSI, Canada |
| MMG | Diversified, ICMM, China |
| Alrosa | Diamonds, Russia |
| Vedanta | Diversified ICMM, WBCSD, India |
| Teck Resources | Diversified, ICMM, DJSI, Canada |

**Table 3**
Companies used as peer group.

| Name | Industry Group |
|---|---|
| BMW | Automobiles & Components |
| Koninklijke Philips | Capital Goods |
| LG Electronics | Consumer Durables & Apparel |
| UBS Group | Diversified Financials |
| Thai Oil | Energy |
| Unilever | Household & Personal Products |
| Swiss Re | Insurance |
| Koninklijke DSM | Materials[a] |
| Hewlett Packard | Technology Hardware & Equipment |
| PostNL | Transportation |
| Iberdrola | Utilities |
| Stockland | Real Estate |

[a] Mining is part of the materials group, with DSM being the overall leader. Newmont is the leader of the mining sub-group.

Following the above literature review, a qualitative analysis of the mining companies listed in Table 1 is conducted. We focus on the large companies, since by and large they can be considered the sustainability leaders in the industry through their membership of ICMM and they were also the ones initiating the GMI. We include the largest diversified (mining for multiple commodities) companies and the largest in single commodities such as steel, gold, uranium and diamonds, look - beyond ICMM-if they are members of WBCSD or listed in the Dow Jones Sustainability Index (DJSI – see below) and cover a broad range of countries (based on where their head offices are).

We use information available on their webpages and their sustainability reports (references in the Appendix) and assess them against the following two criteria, the first is a key word analysis looking at signs of "strong sustainability" (expressed through the key words ecological economics/natural capital, planetary boundaries, Vision 2050; selected based on the concepts we describe above as supporting "strong sustainability") and societal mainstream (SDGs) in the sustainability vision/strategy and the second looking for these signs in goals for operational action for the three environmental aspects considered in this paper:

- Does the company consider any of the following? (Yes or No)
  - Ecological economics or natural capital
  - Planetary Boundaries
  - WBCSD's Vision 2050
  - SDGs
- Does the company have absolute (i.e. at least a cap or real reductions) or relative, efficiency based (which could still lead to absolute increases) targets for climate change, water and biodiversity and what is their context (e.g. the Paris agreement, sustainability of the watershed or "net positive impact" on biodiversity)?

Based on these criteria, we rate each company's position either as "strong sustainability" or "weak sustainability". A "strong sustainability" rating is given when the company has both the vision (as per our key word search) and the supportive absolute targets in place. Table 2 shows the results.

Similar to the mining sustainability frameworks discussed above, none of the mining companies currently support a "strong sustainability" position overall, however some do so for water and/or biodiversity. Our guess is that these are input factors (land in the case of biodiversity) highly relevant to the industry and manageable at an operational level whereas climate change results from an output/waste and is a strategic issue with impact on the business case for many of the companies analysed and thus harder to manage (see below). Teck Resources' position can be considered as the most advanced in the context of this paper, as it is the only company with short and long term (2030), absolute goals, with biodiversity and water based on a sustainability context (which their climate change goal, whilst absolute, isn't). A minority of the companies have absolute climate change targets with many, whilst considering climate change a threat, still having none at all. Only Vedanta is establishing a climate change target based on the Paris agreement, stating that it intends to match the Intended Nationally Determined Contributions (INDCs) in the countries it operates. Indeed, whilst many companies report on their performance and some mention overarching commitments to improvement, they still don't report on specific improvement goals. The companies do not mention their membership commitments other than ICMM's 10 principles (which ICMM obligates them to do) and Newmont

**Table 2**
Results of mining company assessment.

| | Rio Tinto | BHP Billiton | Anglo American | Glen-core | Areva | Arcelor Mittal | Vale | New mont | Barrick Gold | MMG | Alrosa | Vedanta | Teck |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ecological Economics | Y[a] | N | N | N | N | Y[a] | N | N | N | N | N | N | Y[c] |
| Planetary Boundaries | N | N | N | N | N | N | N | N | N | N | N | N | N |
| Vision 2050 | N | N | N | N | N | N | N | N | N | N | N | N | N |
| SDGs | Y | Y | Y | Y | N | Y | Y | Y | N | N | N | Y | Y |
| Climate Change | R | A | R | N | A | R | R | N | N | N | N | A/R | A |
| Water | A/R | A/R | R | N[b] | R | N | N | N[b] | N[b] | A/R | N | R | A |
| Biodiversity | A/R | A/R | A/R | A/R | R | N | A/R | A | R | R | N | A | A |
| Position | W | W | W | W | W | W | W | W | W | W | W | W | W/S |

R - relative A - absolute Y- Yes N - No evidence W - weak sustainability S – strong sustainability.
[a] Some natural and/or social valuation considerations are mentioned.
[b] In development.
[c] Mentions 6 sorts of capital incl. natural capital as input source.

**Table 4**
Results of the peer group assessment.

| | BMW | Philips | LG | UBS | Thai Oil | Unilever | Swiss Re | DSM | Hewlett Packard | Post NL | Iberdrola | Stockland |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ecological Economics | N | Y[a] | Y[b] | Y[a] | N | Y[a] | N | Y[a] | N | N | Y[a] | N |
| Planetary Boundaries | N | Y | N | N | N | N | N | N | N | N | N | N |
| Vision 2050 | Y | Y | N | N | N | N | N | N | N | N | N | N |
| SDGs | Y | Y | Y | Y | N | Y | Y | Y | Y | Y | Y | N |
| Climate Change | R/A | A | A | R | N | R/A | R | R | R/A | R | R/A | R |
| Water | R | A | R | | R | R/A | R | N[c] | R | | R | R |
| Biodiversity | | R | | R | R | R | | R/A | | | R | A |
| Position | W | W/S | W | W | W | W | W | W | W | W | W | W |

R - relative A - absolute Y- Yes N - No evidence W - weak sustainability S – strong sustainability.
[a] Natural and/or other capital considered.
[b] Monetarization used in Korean operations.
[c] Currently assessing water risks.

mentioning their commitment to WEF's Responsible Mineral Development Initiative (RMDI); e.g. neither Vale nor ArcelorMittal as WBCSD members mention Vision 2050. The SDGs are taken seriously by the companies with a majority reporting on their support.

## 5. Other industries – weak or strong?

Subsequently, the mining companies are compared with large companies in other industries listed in Table 3. These companies are chosen because they are the leaders of their respective sector in the current DJSI (RobecoSam, 2016) – itself based on a "weak sustainability" position - and the sector has some relation to mining, e.g. as a customer, supplier or financier.

The criteria and process used are the same as described in section 4, although some of these companies do not consider all three environmental issues as material to their business. Table 4 shows the results.

Philips stands out, as they consider "reducing environmental impact and maintain the resources of our planet - enabling a sustainable planet" (Philips, 2017) and as such is the only company referring to a "strong sustainability" position (which has not yet translated into all its goals, hence the W/S rating). BMW subscribes to Vision 2050 but has no strategy or goals in place to support this, hence the "weak" rating. Given the diversity of this group, not all consider water or biodiversity as material, however where biodiversity is considered the commitments are mostly not as strong (only Stockland supports "net positive contribution for new developments") as the mining companies'. All except Thai Oil and Stockland report on the SDGs and half report some sort of involvement with natural capital initiatives or monetization of environmental issues. On climate change, all but Thai Oil have established targets, with many companies supporting absolute targets for their operations and relative targets for their products.

## 6. Conclusions

Whilst we find evidence for concepts supporting "strong sustainability" in academia and the WBCSD, they have not yet become mainstream in the leading institutions analysed, i.e. the UN - except for climate change (through the Paris Agreement) and biodiversity (through the Aichi Biodiversity targets). The UN's SDGs can be considered the current status of societal expectations and can be seen as a hybrid as described by Neumayer (2003): "Weak sustainability" overall but "strong" in certain areas of natural capital, in this case climate change and biodiversity. This is similar to the mining frameworks analysed, except that these are "weak" on climate change. Further research is required to analyze why the concepts supporting "strong sustainability" are not yet more widely accepted and how they could be promoted further.

The mining companies' overall approach to sustainability is comparable to the peer group. The peer group scores higher on climate change and natural capital valuation, but mining is more advanced in its approach towards biodiversity and water. Almost all companies use definitions based on the three pillar model and a "weak sustainability" position. Only Philips makes reference to a "sustainable planet" and hence a "strong sustainability" position.

The majority of the companies in our analysis are expressing their support for the SDGs, hence are aligned with current societal expectations. It remains to be seen in the coming years how they will contribute towards achieving them, i.e. with regards to climate change in the case of mining.

We come to the conclusion that the mining industry is not setting on the wrong sustainability paradigm at this stage, but is at risk of falling behind societal expectations on climate change and behind the leaders from other industries on natural capital considerations. The industry can improve by considering the Paris Agreement in its approach to climate change, considering natural capital, e.g. through working with the Natural Capital Coalition and more broadly by pro-actively thinking about what the consequences of "strong sustainability" could mean for their business models.

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